PATENT SPECIFICATION

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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Pressure Control Mechanism for an Aircraft Air-Conditioning System

We, UNITED AIRCRAFT CORPORATION, a corporation organized and existing under the laws of the State of Delaware of 400 Main Street, East Hartford, Connecticut, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to pressure control mechanisms for aircraft air-conditioning systems comprising a valve for controlling the flow of air from a compressor of a gas turbine engine.

The use of a servo operated pressure regulating valve to control the pressure downstream of a pressure source is well known. A pressure sensing unit senses the downstream pressure and transmits a signal to the pressure regulator valve so as to adjust the position of the pressure reglating valve to maintain the downstream pressure at a relatively constant level. In the case of a failure of the sensing unit it is desirable to have means for maintaining the system in operation while still providing a signal to indicate that the primary sensing device is no longer operating. It has been found that one can provide a backup system for the pressure regulating, or limiting, valve which will close the valve when the downstream pressure goes above a preset limit and which will not allow it to open until the upstream pressure goes below this limit.

In a system where the pressure source can be controlled, the closing of the valve can act as a warning or signal, and the system can be reactivated after the warning is received by reducing the pressure at the source to below the set value of the limiting valve, thus reactivating the system.

This system operates from compressor bleed air from a gas turbine engine. By putting this valve between the compressor bleed and the air-conditioning system the pilot will be warned of a failure of the primary system by the loss of air-conditioning but may reactivate the system by throttling back and reducing engine speed so as to reduce the compressor bleed pressure.

The object of this invention is to provide a control mechanism which will open a regulating valve when the downstream pressure exceeds a preset limit and which will close the valve when the upstream pressure goes below this preset limit.

This invention may be better understood by reference to the accompanying drawings in which

Figure 1 is a schematic showing this invention embodied in a pressure limiting system for an aircraft air-conditioning system.

Figure 2 is a schematic for an alternative configuration of the overpressure limiting valve 14 shown in Figure 1.

Reference is now made to Figure 1. In this system high pressure bleed air from the compressor 1 of a gas turbine aircraft engine is supplied to an air-conditioning system, not shown, via duct 2. The compressor bleed air pressure may vary from approximately 30 psi to somewhat over 350 psi depending primarily on the design of the engine, the altitude and the speed of the aircraft. The bleed pressure decreases with increasing altitude and ncreases with increasing engine speed and aircraft speed so that the maximum pressure wuld be during high speed operation at low altitudes. In order to minimize weight the air-conditioning system is not designed to withstand high pressures for long periods of time and therefore a pressure limiting system is included in the system to control the pressure of the air going to the air-conditioning system.

The primary control system includes a butterfly valve 8 in the duct, a pneumatic half-area actuator 10 and a primary control valve 12. These mechanisms are well known in the art. Servo pressure from line 50 acts on the

[*Price 4s. 6d.*]

smaller end 11 of the half-area actuator 10 so as to urge it toward the closed position. Servo pressure is supplied to the chamber 20 on the large end of the half-area actuator via line 54. The primary control valve 12 bleeds air from the chamber 20 so as to control the position of the actuator and therefore the butterfly valve 8. Downstream pressure is transmitted to the left side of primary control valve diaphragm 16 via line 17. A regulator spring 18 acts on the other side of the diaphragm. A poppet valve 21 is attached to the diaphragm 16 so as to open line 22, and consequently chamber 20, to ambient when the diaphragm moves to the right. The valve 12 is designed so that the poppet valve 21 will remain closed until the downstream pressure exceeds approximately 135 psi. As the pressure approaches 135 psi the differential pressure across the diaphragm 16 will overcome the spring 18 and cause the poppet valve 21 to open. As the valve opens air will be bleed from line 22 imposing a pressure drop across orifice 51 and consequently causing the pressure in chamber 20 to decrease. This will upset the balance on the actuator 10 and it will move toward the closed position thereby tending to reduce the downstream pressure. As the downstream pressure decreases, becuse of the closing of the butterfly valve, the spring 18 will be able to overcome the pressure differential across the diaphragm 16, and poppet valve 21 will close. In this manner during normal operation the downstream pressure going to the air-conditioning system will be limited to 135 psi.

If the diaphragm 16 in the primary control valve breaks or is punctured during operation there will be no pressure dro across the diaphragm and the spring 18 will cause the diaphragm to move to the left closing valve 21. The primary control valve will be inoperative and unable to bleed, or relieve, the pressure in chamber 20. Assuming for the moment that there is no backup system the pressure in chamber 20 will increase and cause the actuator to open the butterfly valve 8 thereby subjecting the air-conditioning system to full compressor bleed air pressure.

The emergency pressure limiting valve 14 is designed to take over as a control in the event of a failure of the primary control valve 12 so as to prevent damage to the system due to overpressurization. The emergency pressure limiting valve 14 is in parallel so as to be inoperative as long as the primary control valve is regulating the system. If the primary control valve fails, as described above, and the compressor bleed air pressure is high the downstream pressure will increase above 135 psi.

A poppet valve 28 in the emergency pressure limiting valve is designed to bleed air from chamber 20 in the same manner as poppet valve 21. The top surface of the diaphragm 24 is normally acted on by the downstream pressure which is transmitted via lines 17, 36, and 40. A regulating spring 26 acting on the bottom of the diaphragm prevents movement of the diaphragm in the downward direction when the pressure in chamber 34 is below 170 psi. As the downstream pressure approaches 170 psi the pressure differential across the diaphragm will overcome the effect of the spring 26 and the diaphragm will move downward. A plunger connected to the diaphragm will contact the stem 32 on the poppet valve 28 causing the poppet valve to open. This will create a pressure drop across orifice 51 whereby the pressure from chamber 20 will decay and cause the open butterfly valve to move toward the closed position. Without any additions to the system the overpressure limiter valve would now regulate at 170 psi in the same manner as the primary valve regulates at 135 psi. The problem involved with this is that there would be no warning or signal to the occupants of the aircraft to inform them that the primary control valve was no longer functioning. This problem is alleviated by having a cam 56 attached to the diaphragm 24 so as to open poppet valve 42 when the diaphragm moves downward. This will cause the upstream pressure to be admitted to chamber 34 via line 39. Since the upstream pressure is always as high or higher than the downstream pressure the upstream pressure will therefore become the controlling pressure acting on diaphragm 24. Once the diaphragm begins to move down in response to the downstream pressure the poppet valve 42 will open and upstream pressure acting on diaphragm 24 will keep the diaphragm down and maintain the poppet valve 28 in the open position, thereby bleeding chamber 20. This will cause the butterfly valve to move to the closed position thereby reducing the downstream pressure. However, since the upstream pressure is now controlling the emergency pressure limiter valve the butterfly valve will remain in the closed position. In this manner the emergency pressure limiter valve will open when the downstream pressure exceeds a preset limit and will remain open until the upstream pressure goes below this same preset limit. The valve 8 will be closed while the poppet valve 42 is open, thereby blocking the flow of air in duct 2.

An orifice 43 in line 40 is used to restrict the flow from chamber 34 to line 17 when the valve 42 is open.

Two orifices 45 and 46 and a plenum chamber 44 have been added to the emergency pressure limiter valve circuit to reduce the possibility of a tripping of the emergency pressure limiter valve due to rapid changes of upstream pressure. These items provide a lag in the emergency pressure limiting system so as to prevent inadvertent operation of this system.

Figure 2 shows a modification of the emergency pressure limiter valve 14 shown in Figure 1. In this design a poppet valve 57 is directly connected to the diaphragm assembly 24 so as to connect the upstream pressure line 39 directly with the chamber 34 when the diaphragm assembly moves down. The need for a cam follower and spring loaded poppet valve as shown in Figure 1 is eliminated.

WHAT WE CLAIM IS:—

1. A pressure control mechanism for an aircraft air-conditioning system supplied with air through a duct connected to a compressor of a gas turbine engine whereby the control mechanism comprises a valve located in the duct and adapted to be urged toward an open position by an actuator operated by a source of actuating pressure, a pressure limiting means connected to the duct downstream of the valve and to the actuator so as to reduce the actuating pressure when the downstream pressure exceeds a preset limit, and an emergency pressure limiting means connected to the duct downstream and upstream of the valve and to the actuator so as to reduce the actuating pressure when the downstream pressure exceeds a second higher preset limit and to maintain the actuating pressure at a low level until the upstream pressure goes below the second preset limit.

2. A control mechanism according to claim 1 wherein the emergency pressure limiting means comprises a spring acting against the outside of a flexible diaphragm forming a wall of a chamber communicating with the downstream pressure in the duct, a first poppet valve coupled to the diaphragm for bleeding the source of the actuating pressure to ambient when the pressure in the chamber is sufficient to overcome the spring and move the diaphragm, and a second poppet valve coupled to the diaphragm for communicating the upstream pressure in the duct to the chamber when the diaphragm is moved enough to open the first poppet valve.

3. A control mechanism substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*